Multiple Scattering Retrieval of the Martian Atmosphere from TES Spectra during the Noachis Dust Storm

DM Kass, D Crisp, FS Anderson, and the TES team.

The Thermal Emission Spectrometer (TES) measures the IR radiation from Mars. We use a Smith type retrieval scheme to determine the vertical atmospheric temperature structure, dust and ice opacity based on the TES spectra. We are using the nadir looking profiles and thus are concentrating on the lower ~ 40 km of the atmosphere. The retrieval scheme uses a spectrum-resolving multiple scattering radiative transfer code (SMART, Meadows and Crisp [1996]). The inclusion of multiple scattering allows for significant confidence in the retrievals when there is a large aerosol load in the atmosphere. Unfortunately it is also computationally quite expensive and thus can only be used on a small number of spectra.

Our initial work focuses on the Noachis dust storm seen by MGS during the aerobraking phase. This period was chosen because the high dust opacities are where multiple scattering is expected to be the most important. There is also considerable interest in understanding the thermal structure of a Martian dust storm. The temperature profile is primarily derived from the 15 micron CO_2 absorption feature, while the dust opacity is derived based on a broad region around 9 microns. In some cases, we have been able to retrieve some details of the vertical distribution of the dust in the storm. In particular, we can determine the pressure of the "top" of the dust cloud, although this may be sensitive to our assumed dust radiative properties. We have also compared our retrieval results to those done by Conrath et al. [2000].

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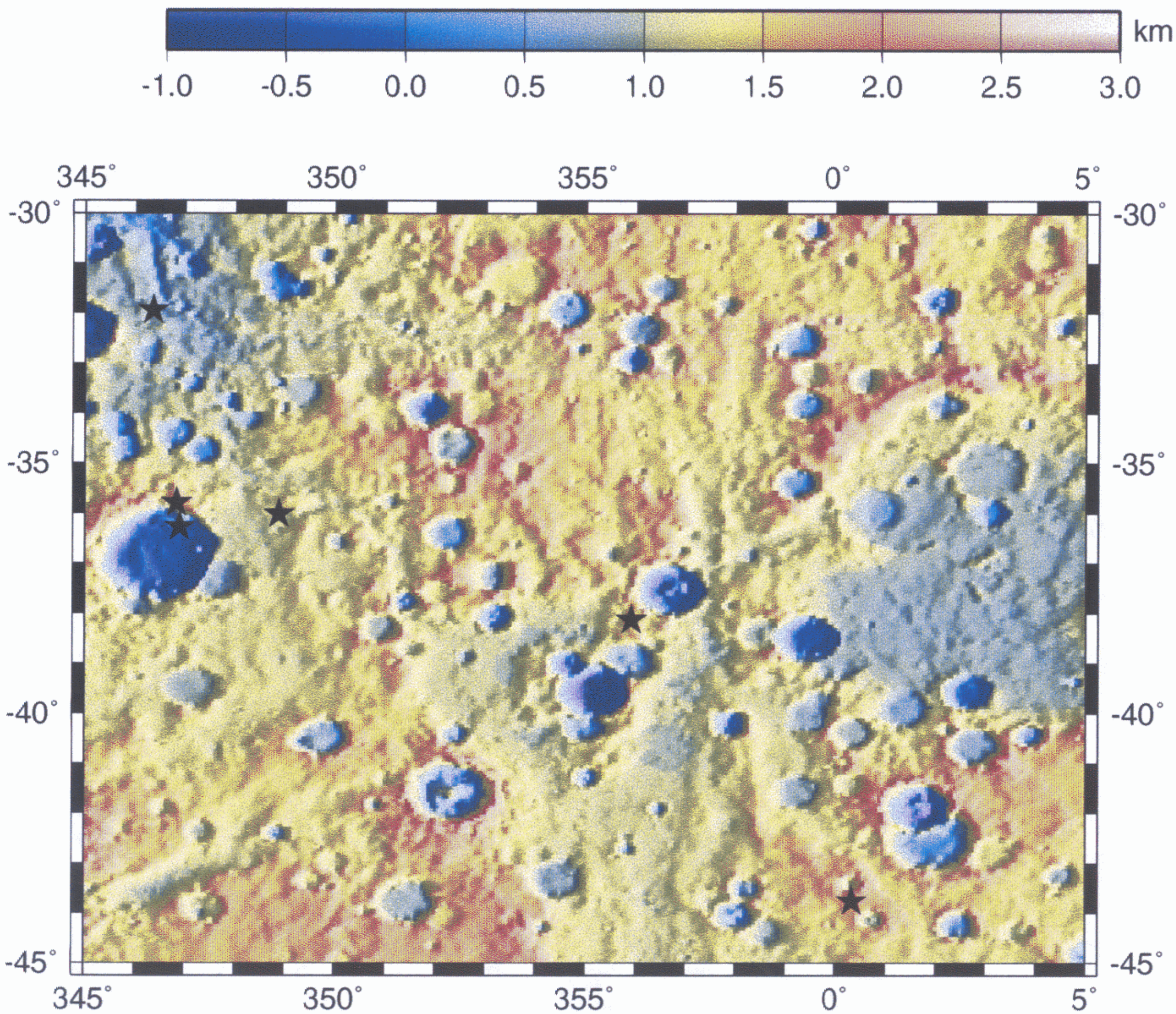

GMT 2000 Oct 20 19:09:02 F.S.Anderson

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DPS 2000, Pasadena

Method

TES nadir observations during Noachis dust storm (Conrath *etal.* [2000])

Smith type iterative retrieval (Smith [1970])

Spectrum-resolving multiple scattering radiative transfer code (SMART, Meadows and Crisp [1996])

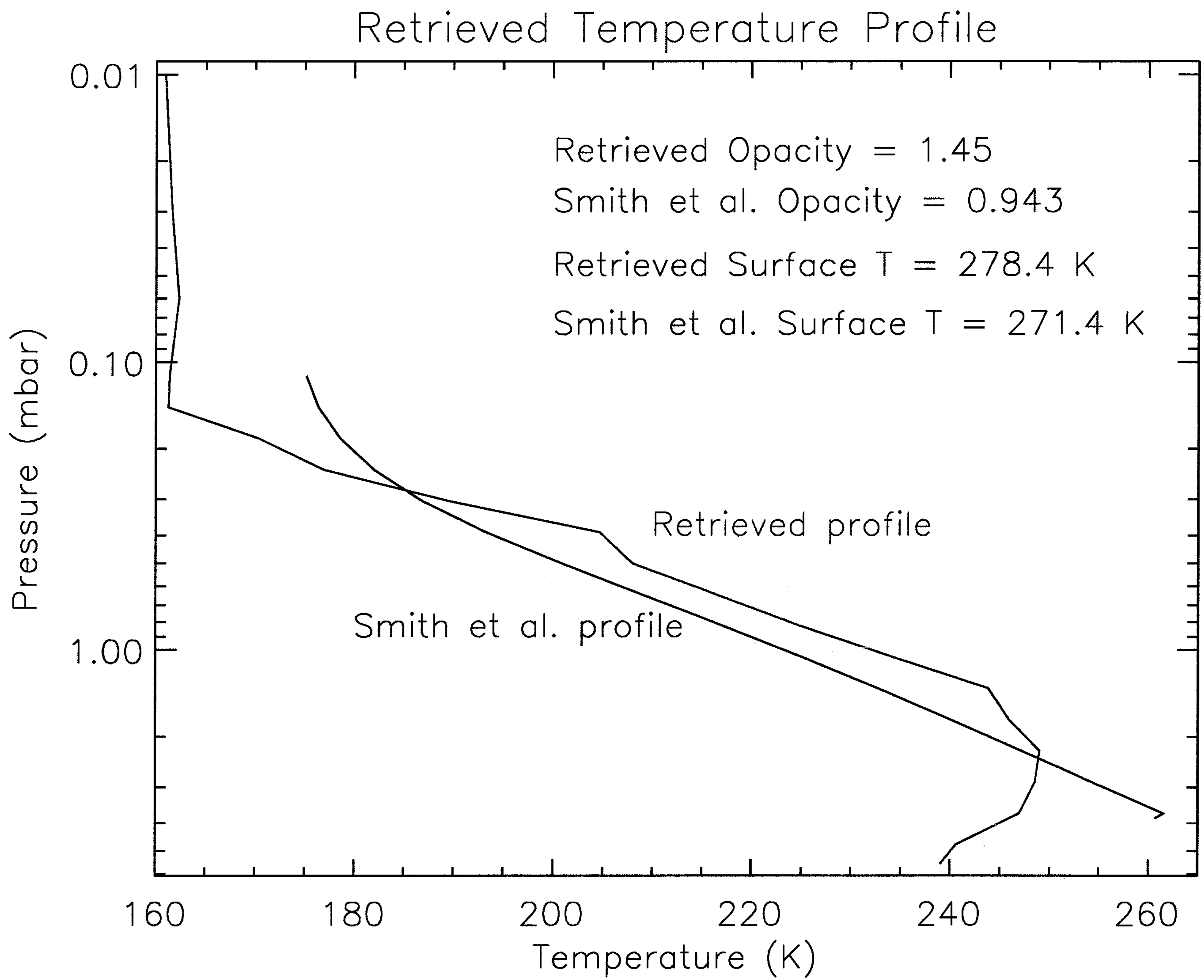
Filtered with TES spectral response functions

Empirically determined gains (by perturbation)

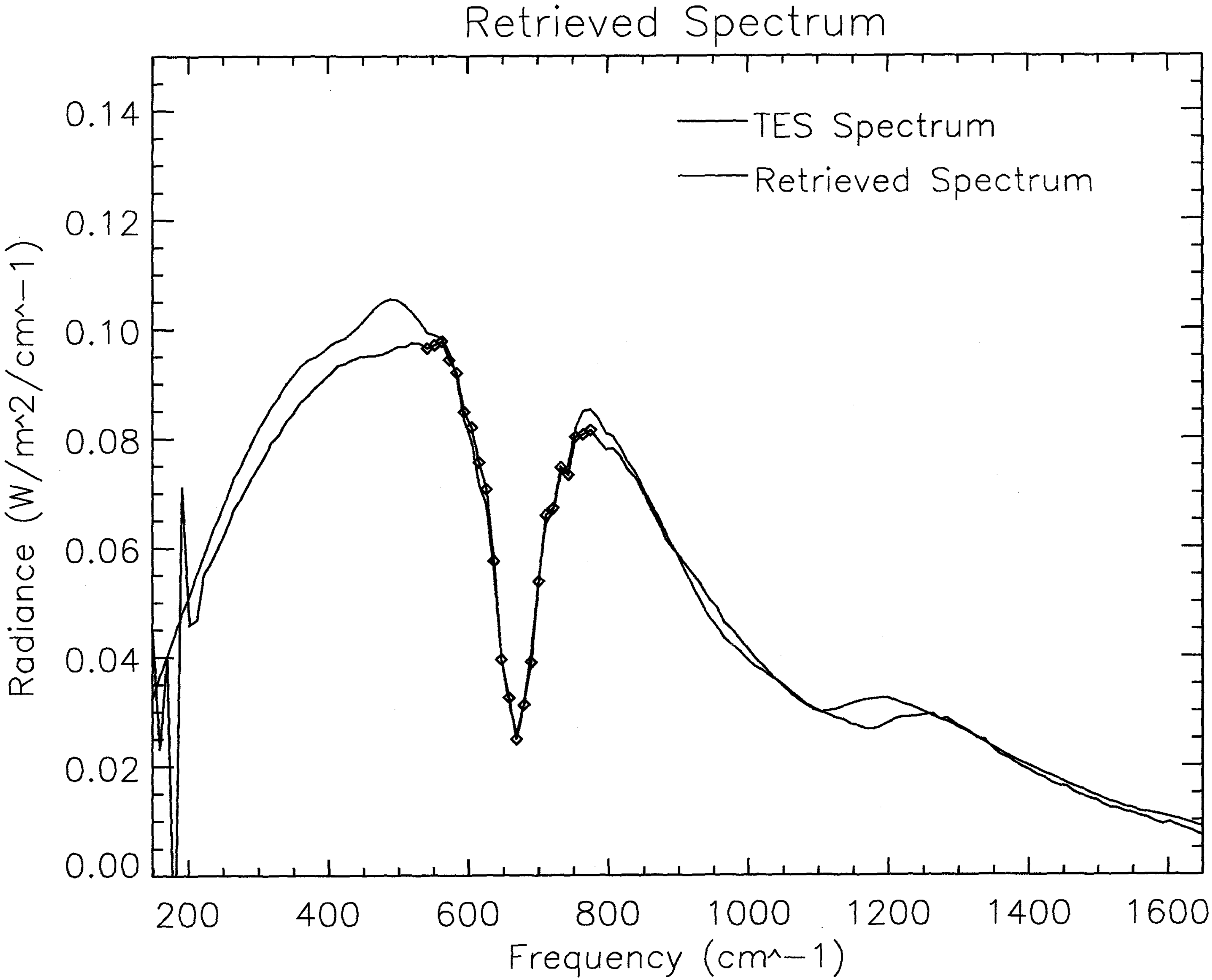
Conrath type dust distribution (Conrath [1974])

Simultaneously retrieve

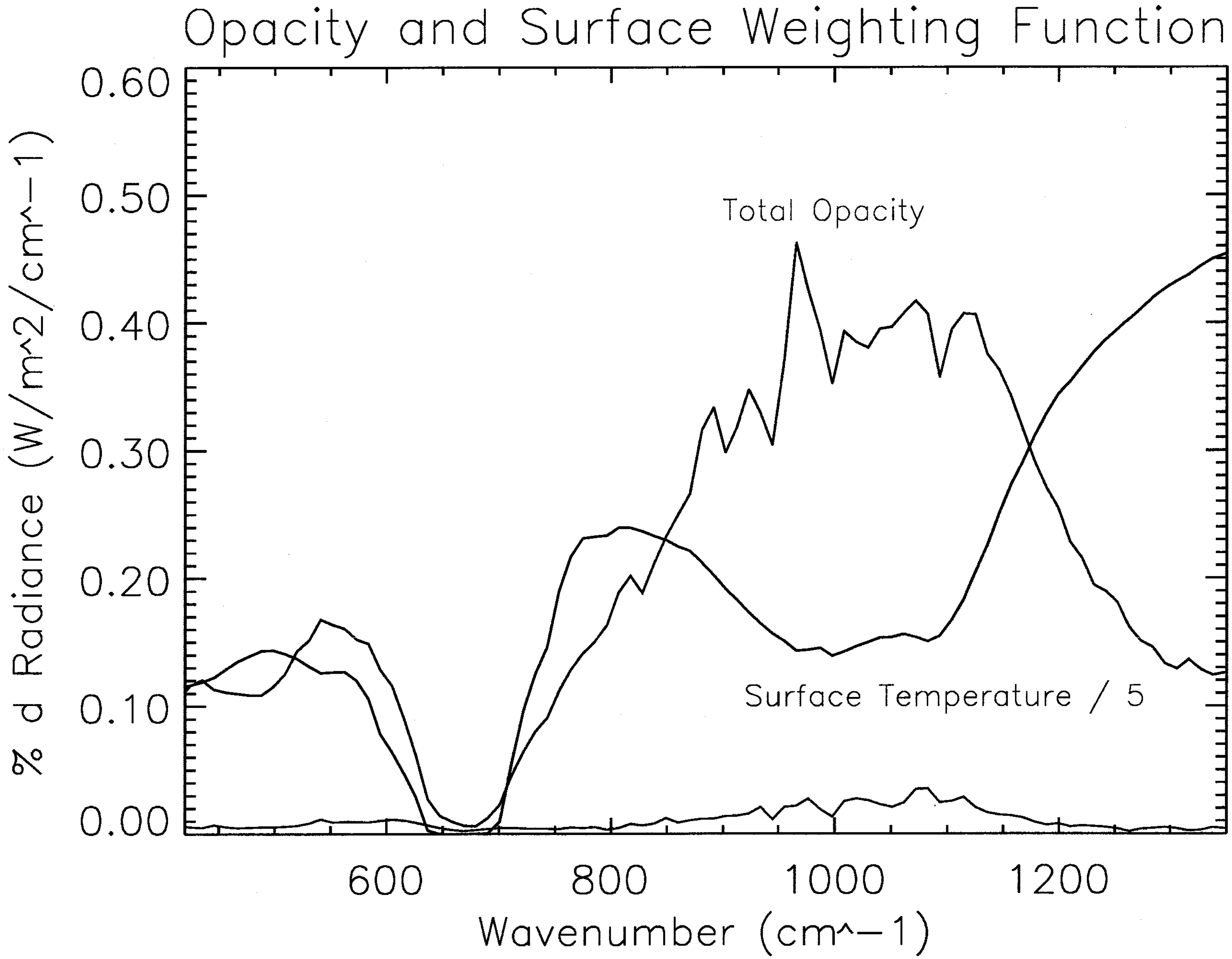
- Atmospheric temperature profile
- Surface temperature
- Column opacity

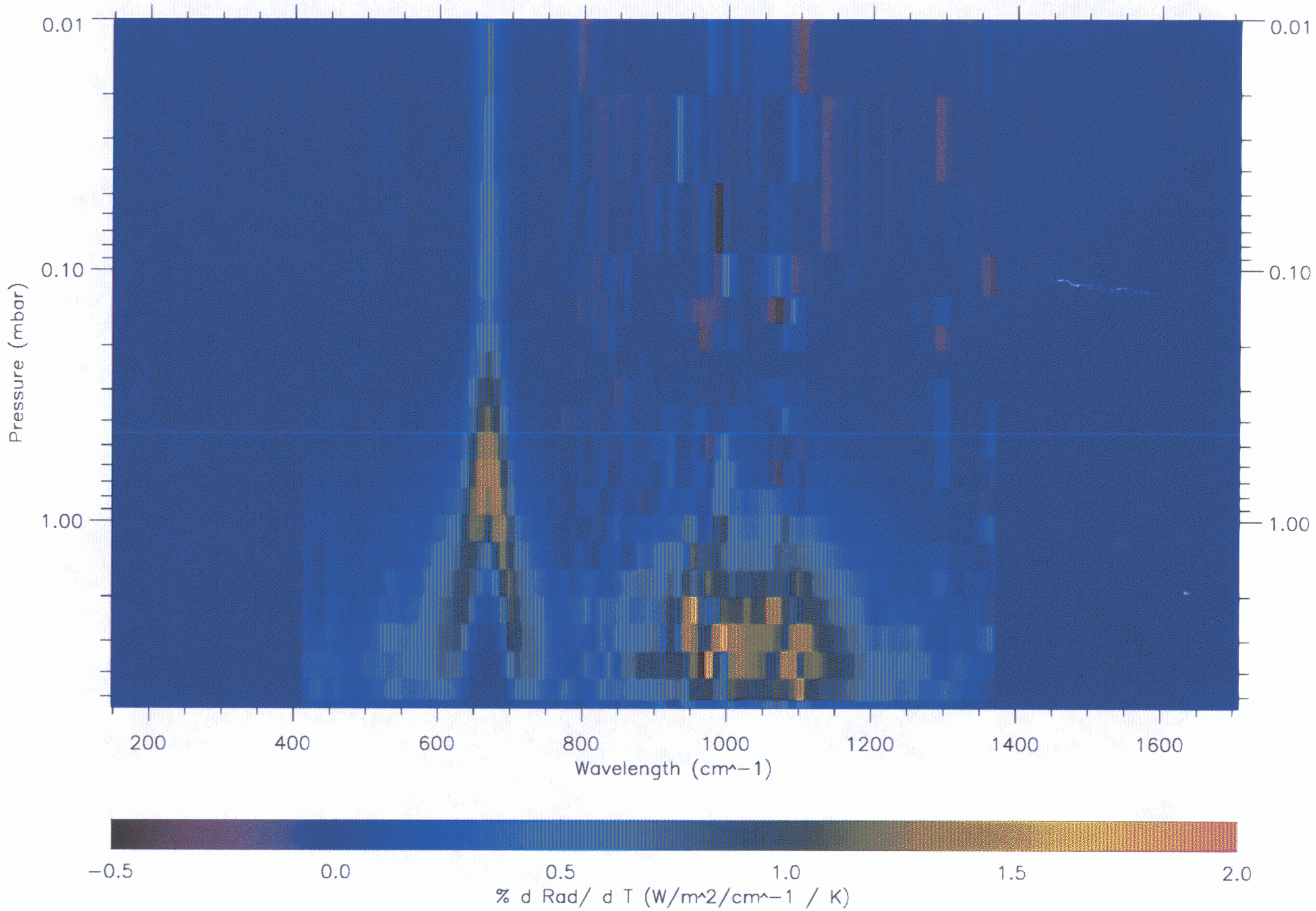


Retrieved Temperature Profile
Retrieved Opacity = 1.45
Smith et al. Opacity = 0.943
Retrieved Surface T = 278.4 K
Smith et al. Surface T = 271.4 K
Retrieved profile
Smith et al. profile
Pressure (mbar)
0.01
0.10
1.00
160
180
200
220
240
260
Temperature (K)



Retrieved Spectrum
TES Spectrum
Retrieved Spectrum
Radiance (W/m^2/cm^-1)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
200
400
600
800
1000
1200
1400
1600
Frequency (cm^-1)


Opacity and Surface Weighting Function
0.60
0.50
0.40
0.30
0.20
0.10
0.00
% d Radiance (W/m^2/cm^-1)
Total Opacity
Surface Temperature / 5
600
800
1000
1200
Wavenumber (cm^-1)



0.01
0.10
1.00
Pressure (mbar)
200
400
600
800
1000
1200
1400
1600
Wavelength (cm^−1)
−0.5
0.0
0.5
1.0
1.5
2.0
% d Rad/ d T (W/m^2/cm^−1 / K)

Further Improvements

- Improved dust optical properties

- Retrieve height of dust falloff

- Retrieve ice clouds (if present)

- Retrieve water vapor (if present)

- Retrieve multiple profiles for horizontal structure